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Citation

Jayakumar, Prakash, and David Ring. 2015. "A Pitfall in Fixation of Distal Humeral Fractures with Pre-Contoured Locking Compression Plate." *Archives of Bone and Joint Surgery* 3 (2): 130-133.

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CASE REPORT

A Pitfall in Fixation of Distal Humeral Fractures with Pre-Contoured Locking Compression Plate

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*Research performed at Hand and Upper Extremity Service, Massachusetts General Hospital, Harvard, USA**Received: 17 November 2014**Accepted: 22 February 2015***Abstract**

Anatomically precontoured locking plates are intended to facilitate the fixation of articular fractures and particularly those associated with osteoporosis. Fractures of the distal humerus are relatively uncommon injuries where operative intervention can be exceptionally challenging. The distal humeral trochlea provides a very narrow anatomical window through which to pass a fixed-angle locking screw, which must also avoid the olecranon, coronoid, and radial fossae. We describe 3 patients (ages 27, 49, and 73 years) with a bicolunar fracture of the distal humerus where very short distal locking screws were used. Intra-articular screw placement was avoided but loss of fixation occurred in two patients and a third was treated with a prolonged period of immobilization. We postulate that fixed-angle screw trajectories may make it difficult for the surgeon to place screws of adequate length in this anatomically confined region, and may lead to insufficient distal fixation. Surgical tactics should include placement of as many screws as possible into the distal fragment, as long as possible and that each screw passes through a plate without necessarily locking in.

Key words: Distal, Failure, Humerus, Locking, Plating**Introduction**

Distal humerus fractures (DHF) are relatively uncommon injuries that are usually treated operatively (1,2). Operative fixation can be technically challenging particularly in patients with osteoporotic bone (3). Locking compression plate (LCP) technology can be useful for articular fractures with osteoporotic bone (4,5). The trochlea of the distal humerus provides a very narrow window to pass a locking screw. Screws must be carefully directed through this window or the screw will enter the joint. Plates with fixed angle locking screws have no flexibility to adjust screw direction once the plate is secured to the column. If the plate is not applied so that the screw will avoid penetrating the articular surface, the surgeon must choose to either change the plate position, accept a shorter screw length, or—depending on the plate—use a non-locking screw.

We describe three patients in whom very short distal locking screws were used, presumably to avoid placing the fixed angle screw in a maloriented position into the joint or fossa. We believe that these short distal screws

resulted in inadequate distal fixation that contributed to early loss of fixation in two patients and required prolonged immobilization in the third patient.

Case Report

Between October 2009 and October 2013, three patients with bicolunar DHFs fixed with pre-contoured LCPs (Synthes, Paoli, PA) and short distal locking screws were identified by one of two surgeons at our level-I trauma center. All three were women aged 27, 49, and 73 years. Two patients underwent primary operative fixation at regional hospitals prior to receiving treatment at our unit, whilst one had both the index procedure and revision surgery at our center. Revision open reduction internal fixation was indicated for loss of fixation in two cases and one patient was treated with immobilization. Between 3 and 5 months after surgery all 3 patients had at least 100 degrees of elbow flexion and extension, radiological union, had returned to their pre-injury activities, and were discharged from care.

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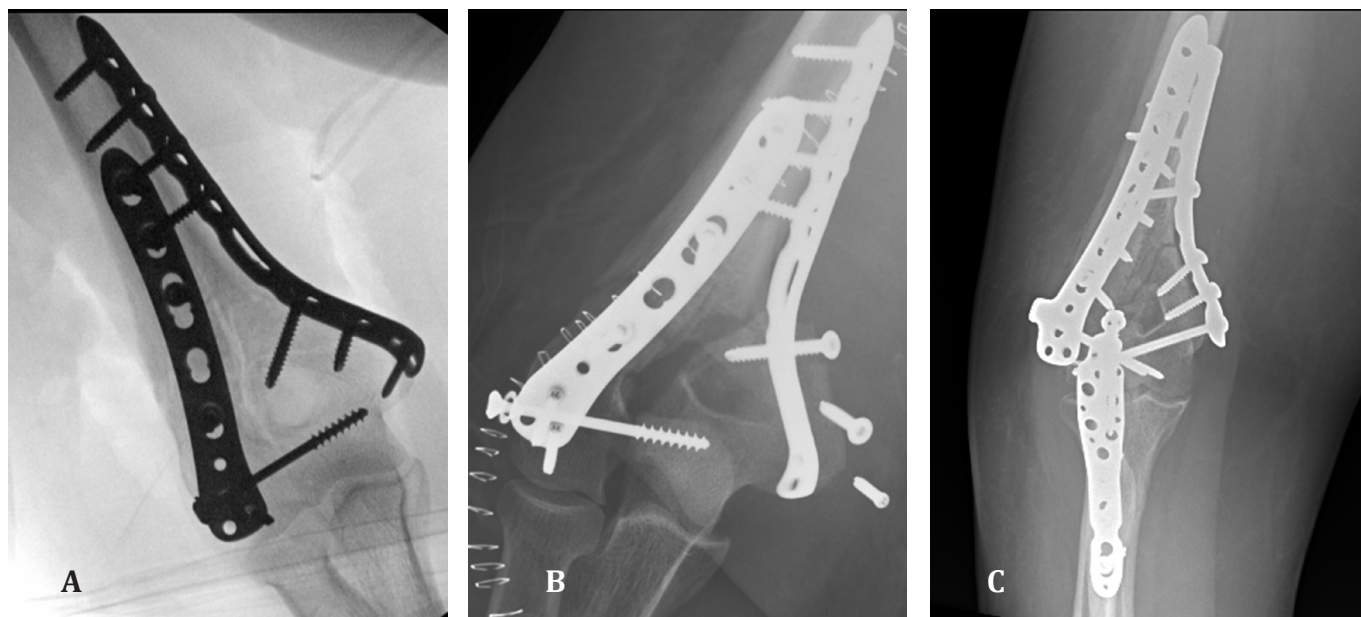


Figure 1. Patient 1 is a 49-year-old woman with a bicolumnar distal humerus fracture.

A: An intra-operative anteroposterior image intensifier image demonstrates short locking screws in the distal part of the medial plate.

B: Two weeks later, an anteroposterior radiograph demonstrates loss of fixation of the distal aspect of the medial plate.

C: An anteroposterior radiograph after a second surgery shows longer standard medial screws placed through a 3.5-millimeter reconstruction plate.

Patient 1

A 49-year-old left hand dominant, overweight woman bus driver with coronary artery disease sustained a bicolumnar intra-articular DHF after a mechanical fall, tripping over a cardboard box and landing on the right outstretched upper extremity. The fracture created a simple articular split and relatively high, noncomminuted fractures of both the medial and lateral columns. She underwent open reduction internal fixation (ORIF) without osteotomy and relatively short distal locking screws were used [Figure 1A]. She was splinted for a few days then allowed to start stretching the elbow. Two weeks later she experienced a sudden onset of increased pain and imaging revealed loss of fixation [Figure 1B]. During surgery for repeat ORIF an olecranon osteotomy was performed for exposure. The medial LCP was replaced with a 3.5mm non-locking reconstruction plate and the lateral LCP was revised to an LCP with a lateral extension incorporating 2 long locking screws extending well into the trochlea [Figure 1C]. The non-locking plate made it easier to direct a long screw across the trochlea and into the lateral column. Three months after the second surgery, the fracture had healed and she had returned to light duties at work. She had a 15o flexion contracture and 110o of flexion.

Patient 2

A 27-year-old left-handed woman nanny sustained a left low (meaning that the columnar fractures were at the level of the base of the coronoid and olecranon fossae) bicolumnar extra-articular DHF in a fall on

the outstretched upper extremity whilst skiing. She underwent ORIF with two precontoured LCPs at a regional center the following day. She came to one of us for further care. The distal locking screws were very short and the fixation marginal. In fact, no distal locking screws were used on the medial side [Figures 2A; B]. The distal screws placed through the posterolateral plate are placed off axis and do not thread into the plate. (Figure 2B) She was placed in a removable splint for two more weeks. One month after surgery she was taught active, self-assisted elbow stretches. At discharge 3 months later she had a healed fracture in good alignment, and a 110-degree arc of elbow motion.

Patient 3

A 73-year-old woman sustained a right low bicolumnar intra-articular DHF after falling on the outstretched hand tripping on a rug. She underwent ORIF with two LCPs with short distal locking screws at a regional center the same day. Four weeks post-operatively, she experienced sudden onset pain and swelling and imaging revealed loss of fixation. She underwent revision ORIF where the distal fracture was taken down, realigned and the lateral LCP was exchanged for a longer LCP and the original medial LCP was translated more anteriorly so that longer locking screws could be placed through the trochlea. At discharge 3.5 months later the fracture had healed and she demonstrated a full range of elbow motion.

Discussion

In these three patients, the use of a pre-contoured,

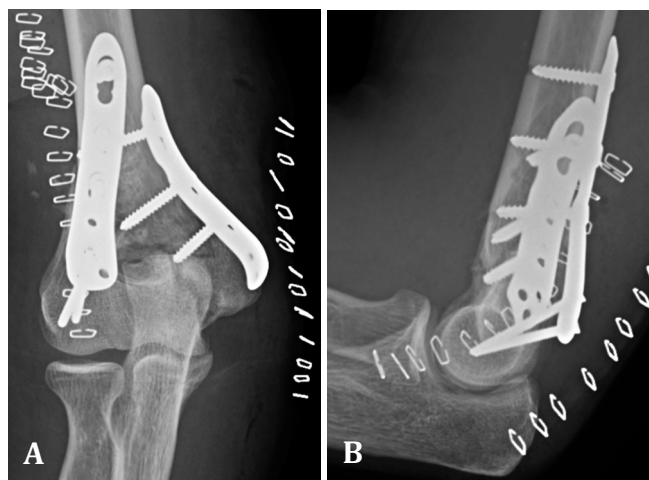


Figure 2. Patient 2 is 27-year-old woman with a bicolumnar distal humerus fractures.

The post-operative anteroposterior (A) and lateral (B) radiographs from an outside facility demonstrate minimal distal fixation on the medial side.

fixed angle distal humerus plates seems to have led surgeons to settle for distal locking screws of suboptimal number and length leading to 2 failures and one patient treated with immobilization to avoid failure. The patient that avoided failure was the youngest patient with the strongest bone and a relatively high fracture of the columns. The trajectory of the screw is constrained by the plate, and requires placement at a fixed-angle compared to conventional plates where the screw can be applied in a range of directions. This is particularly important given the complex anatomy of the distal humerus with the olecranon, coronoid, and radial fossae to avoid and a narrow trochlea to use for fixation (6,7).

Technical aids for determining optimal screw trajectory include use of the LCP drill sleeves, supplementary k-wires, or a stabilizing forceps that helps guide the screw under image guidance as a reference for precision placement of the screw and plate. When using a fixed angle, precontoured LCPs it's important to place one of the distal locking screws prior to anchoring the plate definitively proximal to the fracture. This ensures that the screws can be placed with adequate length without being directed into the joint. Variable angle locking screws are another alternative (8).

Several useful principles outlined by O'Driscoll are helpful for optimizing internal fixation of a bicolumnar fracture of the distal humerus.(9, 10) Relevant to these cases are the principals that every distal screw should

go through the plate, there should be as many screws as possible, and each screw should be as long as possible. When using a fixed-angle, precontoured locking plate it is necessary to have the distal portion of the plate very precisely positioned to be able to fulfill these criteria for good fixation.

This is not the first pitfall noticed with distal humerus locking plates. In angular stable locking compression plating in orthogonal configurations, distal screw pull-out has been reported at the lateral column (9,10). The distal screws of a posterolateral plate are short, unicortical (to avoid the capitellar articular surface anteriorly), and placed within metaphyseal bone. Abduction of the shoulder places a varus stress on the arm, leading to axial failure (the screws pull directly out of the bone in line with their trajectory) of these short screws, even when they are locking screws.

The limitations of this study include the relatively small number of patients who were analyzed retrospectively. There is no comparison with cases during the same period that had adverse events despite more standard screw lengths, patients requiring revision for other reasons, or patients with short screws that did well.

Anatomically precontoured LCPs provide angular stable fixation for complex intra-articular DHFs. However, the fixed-angle screw trajectories may make it difficult for the surgeon to place screws of adequate length in this anatomically confined region and may lead to insufficient distal fixation in these challenging fractures. The ability to recognize this type of pitfall and disseminate information beneficial to surgeon and patients depends on open reporting of adverse events and / or tracking through large prospective databases. We recommend that surgeons place as many screws as possible in the distal fragment, as long as possible, and that each screw pass through a plate. We don't feel it's necessary that the screws lock to the plate.

Pre-contoured, fixed angle plating devices should be utilized with caution in the anatomically confined region of the distal humerus. The surgeon should be mindful of the principles of achieving optimal anatomical stabilization and have a low threshold for switching surgical tactics if fixation (i.e. screw number, length, plate orientation) is constrained by these systems.

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